Flipped Classroom Activity Guide

Unit 5 — Stoichiometry and the Mole

Pre-class reading, in-class stations, worksheet, and post-class assessment

Grade 10 Chemistry | 28 students, 7 groups | 55-minute period | Week of Oct 12

"Students arrive already knowing what a mole is — class time is for practicing the hard part: turning grams into answers."

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1 Overview

This guide converts three class periods on stoichiometry into a flipped sequence: students meet the vocabulary and worked examples at home, then spend class time doing the part that actually needs a teacher in the room — solving problems, getting stuck, and getting unstuck. The approach follows the model popularised by Bergmann and Sams [2012] and is supported by the active-learning evidence synthesised in Freeman et al. [2014], which found a 12% average exam-score gain when lecture time is replaced with structured practice.

Learning Objectives

By the end of this unit, students will be able to:

1. Convert between mass, moles, and number of particles using molar mass.
2. Balance chemical equations and identify mole ratios from coefficients.
3. Calculate the mass or moles of a product formed from a given mass of reactant (mole-to-mole and mass-to-mass stoichiometry).
4. Identify a limiting reactant in a two-reactant system and justify the choice in writing.

The Flipped Cycle

Figure 1 shows how the three phases of this guide fit together. Each phase has a distinct job: the pre-class phase transfers information, the in-class phase builds skill through feedback, and the post-class phase checks whether the skill transferred.

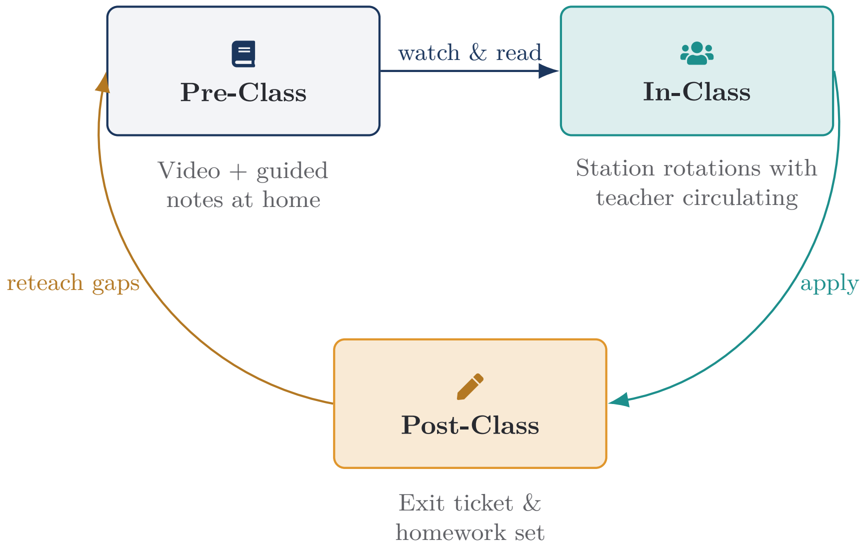

Figure 1: The three-phase flipped cycle used in this unit.

Teacher Tip

If more than a third of the class arrives without having done the pre-class reading, do not lecture to fill the gap — run the 5-minute warm-up quiz in Section 3 anyway, let students self-score, and redirect unprepared students to the reading during station 1 while prepared students start station 2. Protects class time for the students who did the work.

2 Pre-Class Preparation

Assigned two days before the in-class session through the Nexa LMS. Estimated completion time: 25–30 minutes. Completion is graded on effort (guided-notes submission), not correctness — correctness is checked in class.

Assigned Resources

Resource	Description	Time
Video: "The Mole and Molar Mass"	Nexa Chemistry channel, episode 5.1; covers Avogadro's number and molar-mass conversions with worked examples	9 min
Video: "Balancing to Ratios"	Nexa Chemistry channel, episode 5.2; shows how balanced coefficients become mole ratios	7 min
Reading: *Stoichiometry Primer*, pp. 112–118	Course textbook excerpt; worked mass-to-mass example with the classic $N_2 + 3H_2 \rightarrow 2NH_3$ reaction	10 min
Guided notes worksheet	Five short-answer prompts, submitted before class starts	5 min

Guided Notes Prompts

Students submit written answers to the following before class. These are scanned (not graded for correctness) so the teacher can regroup students by readiness at the start of class.

Q1. In your own words, what does a mole count, and why do chemists use it instead of counting individual atoms?

Q2. Write the molar mass calculation for CO_2 (show each element's contribution).

Q3. In the equation $N_2 + 3H_2 \rightarrow 2NH_3$, what is the mole ratio of H_2 to NH_3?

Q4. What is one step in the worked example (textbook p. 116) that you found confusing?

Q5. Rate your confidence with mass-to-mass conversion from 1 (lost) to 5 (could teach it).

Teacher Tip

Question 5's confidence ratings are the fastest way to pre-sort station groups. Pull the 1–2 ratings into a teacher-led station instead of rotating them through peer stations first — they need direct instruction before peer practice is useful to them.

3 In-Class Session Plan

A single 55-minute period, structured around three rotating stations plus a warm-up and a debrief. Groups of four, formed from the confidence ratings collected in Section 2.

Materials Needed

- Station cards (Sections 4, one set per group)
- Molar-mass reference sheet (periodic table with masses), 1 per student
- Whiteboards and dry-erase markers, 1 set per group
- Timer displayed at the front of the room
- Colour-coded exit tickets (Section 5)

Agenda

Time	Segment	What happens
0:00 – 0:05	Warm-up quiz	Three cold-call conversion problems on the board; self-scored, hands raised for 0–3 correct
0:05 – 0:15	Station A — Mole Conversions	Grams ↔ moles ↔ particles drills on whiteboards
0:15 – 0:25	Station B — Mole Ratios	Balance equations, extract ratios, answer "how many moles of X per mole of Y"
0:25 – 0:35	Station C — Mass-to-Mass	Full stoichiometry problems using the ammonia synthesis reaction
0:35 – 0:45	Station D — Limiting Reactant	Two-reactant problem set with a Nexa Labs sample scenario
0:45 – 0:52	Whole-class debrief	One volunteer per station walks the room through their group's hardest problem
0:52 – 0:55	Exit ticket	Individual, silent, submitted before leaving

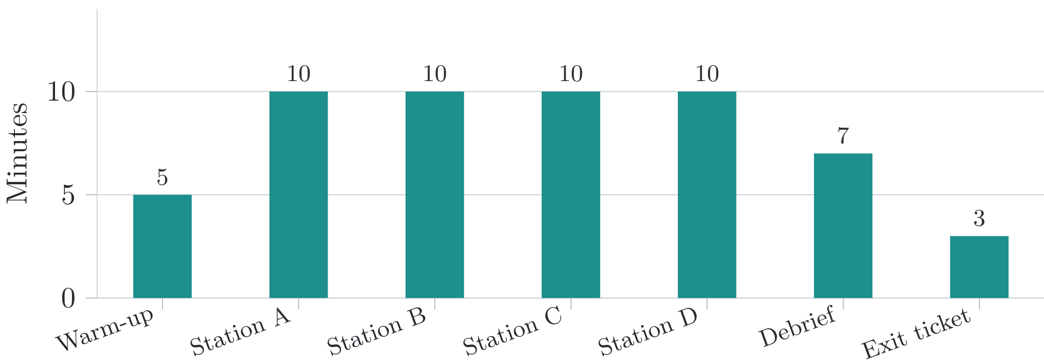

Figure 2: Time allocation across the 55-minute in-class session.

Teacher Tip

Stations run on a shared timer, not a per-group timer — groups that finish early get an "extension card" (a harder variant of the same problem) rather than sitting idle. Keeps the fast-finishers thinking instead of chatting through the remaining minutes.

4 Station Worksheets

Each station card below is printed on cardstock, one per group, with space for whiteboard work rather than answers written on the card itself. The reaction used throughout is ammonia synthesis, so students see the same chemistry get harder at each stop.

$$\boxed{\begin{array}{c}N_2\\ 1\text{ mol}\end{array}} + \boxed{\begin{array}{c}3\,H_2\\ 3\text{ mol}\end{array}} \longrightarrow \boxed{\begin{array}{c}2\,NH_3\\ 2\text{ mol}\end{array}}$$

Balanced equation used across Stations B, C, and D: molar masses $M(N_2) = 28.02$, $M(H_2) = 2.02$, $M(NH_3) = 17.04$ g/mol

Station A — Mole Conversions

A1. How many moles are in 54.0 g of water ($M = 18.02$ g/mol)?

A2. How many particles are in 0.25 mol of carbon dioxide?

A3. A sample contains 1.505×10^{23} particles of glucose. How many moles is this?
A4. Convert 3.0 mol of sodium chloride to grams ($M = 58.44$ g/mol).

Station B — Mole Ratios

B1. Balance: $\_\,C_3H_8 + \_\,O_2 \rightarrow \_\,CO_2 + \_\,H_2O$
B2. From the ammonia equation above, how many moles of H_2 are needed for 5 mol of N_2?
B3. How many moles of NH_3 form from 9 mol of H_2, assuming excess N_2?
B4. Write the mole ratio of O_2 to CO_2 for the balanced equation in B1.

Station C — Mass-to-Mass Stoichiometry

C1. Nexa Labs reacts 40.0 g of N_2 with excess H_2. What mass of NH_3 forms?
C2. Show all four conversion steps (grams → moles → mole ratio → moles → grams) for problem C1.
C3. If 68.0 g of NH_3 is required, what minimum mass of H_2 is needed?

Station D — Limiting Reactant

Scenario: A Nimbus Manufacturing technician mixes 30.0 g of N_2 with 8.0 g of H_2 in a sealed reactor.

D1. Convert both starting masses to moles.
D2. Using the mole ratio, determine which reactant runs out first.
D3. Calculate the mass of NH_3 actually produced.
D4. In one sentence, explain to a classmate why you can't just use the reactant with the smaller mass to decide what's limiting.

Table 1: Answer key reference (teacher copy only — omit from student handout).

Item	Answer	Item	Answer
A1	3.00 mol	C1	48.6 g NH_3
A2	1.51×10^{23}	C3	24.0 g H_2
A3	0.250 mol	D2	H_2 is limiting
A4	175.3 g	D3	45.3 g NH_3

5 Post-Class Assessment

Two components: a two-minute exit ticket collected at the door, and a short homework set graded for correctness and returned before the next flipped unit. Both are designed to surface who needs reteaching before the following class, following the formative-assessment loop described by Talbert [2017].

Exit Ticket

Printed on a half-sheet; students answer individually and silently in the final three minutes.

1. Solve: How many grams of NH_3 form from 14.0 g of N_2 with excess H_2?
2. Circle one: today's material felt **Easy** / **Manageable** / **Confusing**.
3. Write one question you still have, or write "none."

Teacher Tip

Sort exit tickets into three piles while students pack up: correct, close (arithmetic error but right method), and off-track. The "close" pile usually just needs a molar-mass double-check reminder — don't reteach the whole method to that group.

Homework Set

Six problems assigned through the Nexa LMS, due before the next class. Problems 1–4 mirror the station worksheets; problems 5–6 introduce a new reaction (combustion of propane) so students demonstrate transfer, not memorisation of the ammonia example.

Grading Rubric — Station Participation

Used by the teacher while circulating during stations; not shown to students until after class.

Criterion	Proficient (3)	Developing (2)	Beginning (1)
Method shown	All four conversion steps written on the whiteboard, in order	Steps present but out of order or one step skipped	Final answer only, no steps
Units & labels	Every intermediate value labelled with correct units	Units present but inconsistent	Units missing or wrong throughout
Group participation	All four members contribute to the whiteboard	Two or three members contribute	One member does all the work
Use of station time	Group completes the station within the allotted 10 minutes	Group needs an extra 2–3 minutes	Group does not finish the station

Reteach Trigger

If more than 25% of exit tickets land in the "off-track" pile, open the next class period with a 10-minute mini-lecture on mass-to-mass conversion before returning to new content — do not simply move on to Unit 6.

6 Resources & Further Reading

Adapting This Guide

- **Shorter periods (40 min):** Drop Station D and assign the limiting-reactant problem as homework instead; keep the warm-up and debrief.
- **No LMS access:** Print the pre-class reading and guided notes; collect notes on paper at the classroom door instead of online.
- **Mixed-readiness classes:** Pre-sort using the confidence rating (Section 2, Q5) into two station tracks — a supported track that starts with a worked example at Station A, and an independent track that starts directly at Station B.
- **Remote or hybrid students:** Replace whiteboard work with the shared Synapse Notes canvas; the teacher can view all group boards from one dashboard during circulation.

Evidence Base

This guide's structure — transfer information before class, spend class time on practice with feedback — draws on the flipped-classroom literature summarised in Table 2.

Source	**Relevant finding**
Bergmann and Sams [2012]	Introduces the flip model this guide follows: direct instruction moves out of class, class time moves to applied practice.
Mazur [1997]	Peer Instruction shows that structured group problem-solving surfaces misconceptions a lecture cannot.
Bishop and Verleger [2013]	Meta-review of flipped-classroom studies; found consistently positive but modest effects on exam performance.
Freeman et al. [2014]	Meta-analysis across STEM courses: active learning reduces failure rates by roughly a third relative to lecture.
Talbert [2017]	Practical guide to the pre-class/in-class/post-class feedback loop used in Section 5.

Table 2: Evidence base for the flipped structure used in this unit.

Printable Handouts for This Unit

- Guided notes worksheet (Section 2)
- Four station cards, Stations A–D (Section 4)
- Exit ticket half-sheet (Section 5)
- Homework set (distributed separately via Nexa LMS)

References

Jonathan Bergmann and Aaron Sams. *Flip Your Classroom: Reach Every Student in Every Class Every Day*. International Society for Technology in Education, Eugene, OR, 2012.

Jacob L. Bishop and Matthew A. Verleger. The flipped classroom: A survey of the research. *ASEE National Conference Proceedings*, 30(9):1–18, 2013.

Scott Freeman, Sarah L. Eddy, Miles McDonough, Michelle K. Smith, Nnadozie Okoroafor, Hannah Jordt, and Mary Pat Wenderoth. Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23):8410–8415, 2014.

Eric Mazur. *Peer Instruction: A User's Manual*. Prentice Hall, Upper Saddle River, NJ, 1997.

Robert Talbert. *Flipped Learning: A Guide for Higher Education Faculty*. Stylus Publishing, Sterling, VA, 2017.